Trading off dietary choices, physical exercise and cardiovascular disease risks

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Abstract

Despite several decades of decline, cardiovascular diseases are still the most common causes of death in Western societies. Sedentary living and high fat diets contribute to the prevalence of cardiovascular diseases. This paper analyses the trade-offs between lifestyle choices defined in terms of diet, physical activity, cost, and risk of cardiovascular disease that a representative sample of the population of Northern Ireland aged 40-65 are willing to make. Using computer assisted personal interviews, we survey 493 individuals at their homes using a Discrete Choice Experiment (DCE) questionnaire administered between February and July 2011 in Northern Ireland. Unlike most DCE studies for valuing public health programs, this questionnaire uses a tailored exercise, based on the individuals' baseline choices. A "fat screener" module in the questionnaire links personal cardiovascular disease risk to each specific choice set in terms of dietary constituents. Individuals are informed about their real status quo risk of a fatal cardiovascular event, based on an initial set of health questions. Thus, actual risks, real diet and exercise choices are the elements that constitute the choice task. Our results show that our respondents are willing to pay for reducing mortality risk and, more importantly, are willing to change physical exercise and dietary behaviours. In particular, we find that to improve their lifestyles, overweight and obese people would be more likely to do more physical activity than to change their diets. Therefore, public policies aimed to target obesity and its related illnesses in Northern Ireland should invest public money in promoting physical activity rather than healthier diets.

Keywords: Northern Ireland, Dietary choices, Choice experiments, Willingness to pay for risk reduction, Cardiovascular diseases

1. Introduction

Obesity and overweight have become a growing problem affecting most of Western societies. According to the World Health Organization (WHO), in 2008 there were about 1.5 billion overweight adults. This figure is increasing dramatically because of our sedentary lifestyles and worsening eating habits (World Health Organization, 2011). In Northern Ireland almost 60% of adults are either overweight or obese, and, according to the Public Health Agency, this figure is growing (Department of Health, Social Service and Public Safety, 2011).This epidemic has become an economic burden (Muller, 2007), as well as a major health problem, as obesity increases the risk of type 2 diabetes, cancer and cardiovascular diseases (CVD). As a result, governments and public health agencies are diverting considerable resources to prevent obesity and promote healthy lifestyles (World Health Organization, 2001; Fit Futures, 2006; Foresight Report, 2007; Department of Health, Social Service and Public Safety, 2010). Thus it is important to explore strategies that help people choose healthier lifestyles and to estimate their willingness to pay for improvements in their health and for reductions in their risk of disease.

A discrete choice experiment (DCE) survey is the appropriate framework to analyse individuals' stated behaviour in response to a broad range of hypothetical choices (Ben Akiva & Lerman, 1985; Louviere, Hensher, & Swait, 2000; Train, 2009; Carlsson & Martinsson, 2003; Ryan, Gerard & Amaya, 2008). DCEs allow researchers to analyse to what extent, and under what conditions, individuals are willing to change their unhealthy lifestyles for healthier ones. This health improvement is presented here in terms of a reduction of the risk of suffering from CVD, which are among the most serious obesity-related health problems, in the context of food choices and physical activity behaviour.

Food choices and risk have been analysed with respect to genetically modified food (Rigby & Burton, 2005, 2006), traceability (Van Rijswjk & Frewer, 2008) and food safety (Lobba, Mazzocchi & Trail, 2007). Most of these studies are based on one single choice or a set of single choices. Conversely, in our study, we set a more realistic framework for dietary choices, which implies a series of regular choices over many years. In addition, respondents are not asked to choose between artificial scenarios completely unrelated to their own habitual food choices and amounts of physical activity. We tailor our DCE questions using individuals' actual diet, level of physical activity and the CVD risk they face.

Dietary choices are based on habit but are the result of a trade-off between taste (sensory perceptions), health, cost, and among other attributes, attitudes, values, and beliefs (Furst et al., 1996). Cardiovascular diseases are known to be highly correlated with high levels of cholesterol in the blood (Mente et al., 2009), part of which comes from an excess of saturated fat intake. At the same time, the presence of fat is correlated with taste and palatability in food. On the other hand, a sedentary lifestyle tends to be correlated with high levels of cholesterol in the diet (Lakdawalla & Philipson, 2009; Auchincloss et al., 2009). Despite its well-known benefits, the majority of people in the UK do not engage in regular physical activity. Physical activity levels are declining in Northern Ireland (NI), with 23% of the population classed as sedentary (Northern Ireland Health and Social Wellbeing Survey 2005/06).

In this paper, our DCE asks a representative sample of the adult population of Northern Ireland to choose between their current lifestyle, described in terms of their own dietary habits, levels of physical activity and actual risk of suffering a fatal CVD in the next ten years, and other hypothetical lifestyles described by different combinations of diet, exercise, risk of a fatal CVD event in the next ten years, and cost. Cost is shown as increases from respondents' current expenditures. Diets are presented as reductions in the consumption frequency of the most unhealthy (in terms of fat intake) food items consumed by respondents, whilst levels of physical activity are described in terms of increments from respondents' current levels measured in minutes.

The remainder of the paper is structured as follows. Section two briefly describes the DCE method; section three gives an overview of the questionnaire used and reports the descriptive statistics of the sample of the Northern Ireland population we surveyed; section three reports the results of the econometric models and discussion; section four concludes the paper with policy implications.

2. Methodology, questionnaire and data collection

2.1 Methodology

Choice models are based on the idea that individuals make choices among alternatives by considering the characteristics of the alternatives (Lancaster, 1966). When facing a set of *J* alternatives, individuals will pick the one providing the highest utility. DCEs are grounded in random utility theory, which states that individual's choices produce certain utility, *U*, which contains a modelled part, *V*, that can be measured in terms of the attributes of each alternative, and another part, ε, that cannot be observed by researchers and therefore it is considered a random term and named the unmodelled part of the utility (see Ryan, Gerard & Amaya, 2008, and Ryan & Gerard, 2012).

By observing peoples' choices, the modeller can estimate the weights attached to each attribute; these, in turn, allow for the calculation of the marginal willingness to pay (WTP) for improving each of these characteristics. Assumptions made about the distribution of the random error component lead to different types of model. The simplest one is the multinomial logit (MNL) model which assumes that errors are independent and identically distributed (i.i.d.) according to a Type 1 extreme value distribution. Unlike the MNL, a Random Parameter Logit (RPL) model allows heterogeneity in tastes by assuming that the parameters β_s are not fixed, but vary across respondents. The common formulation is that the β_s differ in terms of taste intensity (Train, 1998), leading to the following utility specification obtained by individual *q* from choosing alternative *j*:

$$U_{qj} = \widetilde{\beta_q} x_{qj+} \epsilon_{qj} \qquad (1)$$

Where X is a vector of attributes describing alternative j and the random taste parameters $\tilde{\beta}_q$ depend on the values of the parameters θ of an underlying "mixing distribution" $f(\beta|\theta)$. Researchers have to make assumptions about the distributions of the random component.

For the MNL, the WTP for an attribute is calculated as the negative of the ratio between that attribute coefficient and the cost attribute, and welfare estimates can be calculated as described in Lancsar & Savage (2004). Whenever random parameters are used, this formula is not so straightforward (Armstrong, Garrido & Ortúzar, 2001). In such a case, the calculation of means and confidence intervals would be difficult, although the distribution itself may still exist. For this reason a different parameterization of the utility function – namely WTP–space – has been recently developed (Train & Weeks, 2005). In further applications, WTP-space has been shown to provide more realistic and informative welfare estimates obtained from DCE data (e.g., Train & Weeks, 2005; Scarpa, Thiene & Train, 2008; Balcome, Chalak & Fraser, 2009). Moreover, as documented in Train & Weeks (2005) and in Scarpa, Thiene & Train (2008), a random cost coefficient in a WTP-space model allows for individual scale heterogeneity – even if it is confounded with the cost coefficient (Thiene & Scarpa, 2010 and Scarpa, Thiene & Hensher, 2012). WTP-space is a transformation of the utility function that involves expressing all non-cost parameters estimates as ratios with the cost coefficient. As discussed by Louviere (2006), if errors are i.i.d. type-one extreme value, there is no difference in the fits of the two models, except for rounding errors. This re-parameterization of the utility function allows the direct estimation of population moments. The utility function is re-written by substituting for each attribute k the parameter β_k with a new parameter which is a direct estimate of the WTP by noting that $\beta_k = \beta_{cost} \cdot WTP_k$.

In order to obtain more accurate WTP values from the observed sample for policy recommendations, we compute the WTP for each attribute for each individual $(WTP_{k,q})$

conditional to the pattern of choices observed, y_q. The coefficients for the model at an individual level can be computed using the estimator proposed by Scarpa, Campbell & Hutchinson (2007):

$$\hat{E}\ [WTP_{k,q}] = \frac{\frac{1}{R}\sum_{r=1}^{R} \widehat{WTP}_{k,q}^{r}\ L(\widehat{WTP}_{k,q}^{r} | y_q, X_q)}{\frac{1}{R}\sum_{r=1}^{R} L(\widehat{WTP}_{k,q}^{r} | y_q, X_q)}, \quad (2)$$

where $L(.)$ is the posterior likelihood of the individual respondents and the $\widehat{WTP}_{k,q}^{r}$ are drawn from the multivariate normal computed at the Maximum Simulated Log-likelihood estimates using $r=1,2,\ldots R$ draws. In our calculation we will use R=100,000 Halton draws.

2.2 Questionnaire

We used computer assisted personal interviews (CAPI) during the months February – July 2011 to administer a questionnaire to a sample of 493 individuals aged 40-65 representative of this age group in Northern Ireland. Ethical approval for this study was obtained by the Ethical Research Committee of the School of Biological Sciences, Queen's University Belfast. The questionnaire is divided into five parts: health and physical activity, diet, a risk tutorial, the DCE choices, and socio-demographic questions. The DCE questions were tailored and individually generated to take account of each respondent's current dietary choices, levels of physical activity and fatal CVD risk, thus making the experiment realistic to the subject.

We began with general questions about health, adapted from the MOS SF36 Health questionnaire (McHorney et al, 1994), and asked respondents about health conditions related to diabetes, smoking, arthritis, systolic blood pressure, cardiovascular diseases, family history of cardiovascular diseases and individual's weight and height. For example, when enquiring about respondents' health, we asked: "In general, would you say that your health is... Very good; Good; Fair; Poor; Very Poor; Don't know/Refused". We then asked questions about age, gender and postcode address. These health data were incorporated into the QRISK1 prediction algorithm developed by the University of Nottingham for CVD risk in the British population (Hippisley-Cox et al., 2008) to estimate respondents' own CVD risks. The outcome of the algorithm, in terms of the percentage risk of having a heart attack or stroke in the next ten years was then shown to respondents and later reported in the "status quo" option in the DCE questions. Physical activity questions were based on the UK National Health Service version of the International Physical Activity Questionnaire (IPAQ) (Craig et al, 2003) to elicit respondents' engagement with moderate activities (household, gardening, shopping), moderate exercises (walking, cycling) and vigorous physical activities. For example, respondents were asked "During the last week, how many hours did you spend walking, including walking to work, shopping, for pleasure etc.? None; Some but less than 1 hour; More than 1 hour but less than 3 hours; 3 hours or more; Don't know/Refused".

To determine people's willingness to modify their diet in exchange for health improvements, we collected information about respondents' current eating habits. As we deemed impractical for a CAPI interview to use a diary of food intake during one week, we focused on eliciting respondents' consumption of food items with a high fat content, as these items could lead to high levels of blood cholesterol and, therefore, are likely to contribute to CVD. We followed the Block Questionnaire (Block, 2000), a tool developed in the nutritional literature, that offers a snapshot of an individual's levels of fat intake through questions about the eating frequency and the portion size for 17 selected items. We adapted the Block Questionnaire to the Irish diet considering the main sources of fat (Joyce et al, 2007), by selecting 17 fatty items often found in the Northern Irish diet: salad dressings (not low-fat); chicken or other poultry (eg. Turkey); beef: roast, steak, mince, stew or casserole; corned beef, spam, luncheon meats; boiled, mashed, instant or jacket potatoes; chips and savoury snacks; cheese; pork: roast, chops, stew or slices; beefburgers; butter; savoury pies, eg. meat pie, pork pie, pasties, steak and kidney pie, sausage rolls; roast potatoes; biscuits, pastries and cakes (not low-fat); bacon; sausages; potato salad; whole milk. Respondents were asked the frequency of consumption of these items from ‘never’ to ‘five or more times a week.’ Each item was presented in a separate screen (see Figure 1). After the frequency, individuals were asked about portion sizes and cooking styles. We would later use the answer to the Block Questionnaire to build the ‘diet’ attribute for the DCE questions, as described below.

Figure 1 about here

The third part of the questionnaire provides a risk tutorial to explain the concept of probability using visual aids. Following a tutorial developed by Alberini et al. (2004) and Alberini & Chiabai (2007) to assess the WTP for reducing mortality risk for cardiovascular and respiratory causes, the concept of probability is taught at first with simple examples and then, by increasing the degree of complexity and abstraction.

The fourth part of the questionnaire presents ten DCE questions. Each DCE question entails three alternatives: the respondent’s current lifestyle and two alternative hypothetical lifestyles. Each alternative is described by a diet, an amount of physical activity, a risk of a fatal CVD event in the next ten years and a cost to the respondent. An example of a DCE question is shown in figure 2.

Figure 2 about here

Just before the DCE questions, a “cheap talk” text (Carlsson, Frykblom, & Lagekvist, 2005) was used to emphasise research findings on the correlation between sedentary lifestyle, excessive fat consumption, poor intake of fruit and vegetables and coronary heart diseases. Cost increases were justified on the basis of the following statement: “these alternative lifestyles will also impact your budget because fruit and vegetables are usually more expensive than other food and physical exercise might also have a cost.”

The final part of the questionnaire asked a set of follow-up Likert scale questions to measure attitudes, perceptions and beliefs about the individuals’ health, and concluded by eliciting respondents’ socio-demographic characteristics.

2.3 Attributes and levels

Physical exercise was defined as minutes spent in a moderate physical exercise per day. The levels of this attribute were: the current level of physical activity, and increases by 10, 20, 30, or 40 minutes per day compared to the current level. The CVD risk was defined as the probability of a fatal heart attack in the next ten years. The status quo level for the current life style was the one resulting from the QRISK1 prediction algorithm. The levels for the other alternative scenarios were calculated as a reduction in such a risk by 40%, 50%, 60%, 75% and 85%. Therefore, for a respondent whose current risk was equal to 5%, a 50% reduction would result in a risk of 2.5%. Cost was described as an increase in the money spent on food and physical exercise per week and its levels were set to £2, £5, £7, £10, £15 and £18, after insights from focus groups, where participants were asked their maximum additional weekly willingness to pay for healthier food consumption, increased levels of physical activity and resulting benefits of decreased CVD risks. The diet attribute was the most complex to define. In focus groups we ruled out the idea of using a hypothetical food basket described in terms of an abstract nutritional content, as such a description would not convey well the information of the ‘taste’ of food and the ‘sacrifice’ resulting from reducing the consumption of favourite food products and from increasing the consumption of fruit and vegetables. We also discarded the possibility of using flagship unhealthy food items, such as pizza, chicken curry, fish and chips, or an 'Irish Breakfast', as they might not have been relevant to all respondents. Therefore, we used the information collected from the Block Questionnaire and selected, for each respondent, the five food items most frequently consumed. The CAPI automatically selected the five items from the Block Questionnaire that were most frequently consumed by each respondent and used these five items to build the DCE questions. This information was presented to respondents under the current choice. The alternative hypothetical scenarios were described in terms of reduction in the consumption of these five items and an increase in fruit and vegetables. We selected four levels for the diet attribute defined in terms of overall fat content. Considering the current diet as the reference value, we defined light, medium, high and restricted diets, corresponding to reductions in fat intake by 10% (light), between 20% and 30% (medium), between 40% and 50% (high) and between 60% and 75% (restricted) from the current diet respectively. This approach allowed us to compare diets across respondents and build a variable expressed in terms of reduction of grams of fat from the current diet. We are aware that this approach may lead to a 'researcher bias,' as in our econometric model we assume that respondents trade off grams of fat when choosing different life styles. However, we are unaware of a more efficient approach to investigate comparable dietary choices across respondents in a tractable way for a DCE survey. Our approach leads to comparable choices, and choices meaningful to respondents. In focus groups we tried adding the information of 'grams of fat', but this information appeared to convey a wrong message, as respondents would only grasp the unhealthy message conveyed by 'grams of fat' and were unable to consider the 'taste' and 'sacrifice' elements of reducing the consumption of their favourite food items. Table 1 shows the attributes and their levels used in this DCE study.

Table 1 about here

Once the attributes and levels were decided, to determine the choice sets and the combination of attribute levels for each alternative, we used a Bayesian D-efficient experimental design, which has been shown to produce smaller standard errors for small samples compared to other experimental designs, such as orthogonal designs (Bliemer & Rose, 2008; Scarpa, Campbell & Hutchinson, 2007; Ferrini & Scarpa, 2007). The design was implemented in two waves, obtaining new priors after modelling half of the sample data. Each respondent was presented with 10 different choice scenarios. The initial priors information was obtained from pre-test and then enhanced with the first wave obtaining -1.38 for status quo, -0.169 for cost, 0.0175 for exercise (in minutes, not in METs as was finally employed in the model) 0.047 for fat and -0.0677 for fatal CVD risk.

The econometric models use the independent variables *Fat*, *Exercise*, *Cost* and *Risk*. *Fat* represents the sacrifice from a respondent's diet, in terms of grams of fat per week that the individual has to give up. This variable was built using the information from the adapted Block Questionnaire and was translated into grams of fat using the study of calories and fat provided by McCance and Widdowson (Food Standard Agency, 2002). *Exercise* in the DCE data analysis was translated into metabolic equivalent of task (MET) which is a unit that expresses the amount of energy necessary to execute each type of physical activity per minute, and is particularly useful for comparing diet and exercise in terms of energy (see Ainsworth et al., 1993). This variable was calculated from the responses to the IPAQ, and the different units of MET that each minute of moderate, medium or vigorous exercise represent. Therefore, its coefficient represents the contribution to utility of one additional unit of MET. *Cost* is the payment for changes in lifestyle, justified in terms of increasing costs of healthy diets, measured in GBP per week. *Risk* is the risk of suffering a fatal CVD event over the next ten years, expressed on a percentage basis. In addition to a specification that includes only the attributes of the DCE, we ran model specifications that included attribute interactions with socio-economic dummy variables, which are described in Table 2.

Table 2 about here

2.4 Data collection

The survey was administered to 493 respondents between February and July 2011 at randomly selected households providing a representative sample of the Northern Ireland population aged 40-65. The sample was stratified by local government district. Within each sampled address, one individual was selected using a Kish Grid method (Kish, 1949); only the person chosen in this manner was eligible for interview. We restricted the sample to respondents aged 40-65 to reduce protest responses from young respondents who might have considered their CVD risk to be zero (Conroy et al., 2003) and from elderly respondents that might have considered the latency of the CVD risk reduction to occur too late in their lifetime.

3. Results

Tables 2 and 3 provide descriptive statistics for the sample. Average net annual income per household was £29,051. Women were slightly over represented, with 57% of the individuals in the sample. The percentage of unemployed was equal to 12%. Regarding Body Mass Index (BMI), the mean was 26.85. About 25% of respondents declared themselves to be in very good health. Regarding physical activity, 41% of respondents engaged in regular vigorous physical activity, 76% walked or cycled at least two hours per week and 80% did some home physical activity at least two hours per week. These figures are coherent with population statistics of Northern Ireland that reports that 59% of adults are either overweight or obese and that 38% do the recommended amount of physical activity (DHSSPS, 2011).

Table 3 about here

3.1 Econometric Modelling

Table 4 displays the output of the estimated MNL models. It is important to note that both parameters for *Exercise* and *Fat* are rescaled by 100 in order for the estimates to be on the same magnitude as the other parameters. The first model is a simple MNL model with the attributes and the current choices as explanatory variables. The output shows that all parameters are highly statistically significant and have the expected signs. In general, respondents dislike being on a diet, as the parameter for *Fat* is negative, indicating that moving to a diet that entails a reduction in fat intake would reduce the respondents' utility. The parameter for exercise is positive, which means that individuals consider physical activity as positively affecting utility. The coefficient estimated for risk is negative and significant, suggesting that respondents eschew alternatives with high risk of a fatal CVD event. To investigate heterogeneity of preferences across respondents, we add interaction terms between socio-economic characteristics of the respondents described in Table 2 and the attributes (MNL-2).

Table 4 about here

Firstly, we notice that unemployed respondents are more reluctant to pay, a result that shows that our data are internally valid. More interesting with respect to the policy implications for health are the interactions with *Fat*, *Exercise* and *Risk*. Heterogeneity in the fat and exercise preferences seems to be well explained by the socioeconomic interactions. Interactions with *Exercise* account for most of the systematic variability with six interaction terms being statistically significant at the 1% level. There are both positive and negative interactions and, in some cases, these change the effect of the main coefficient. The results show that males, overweight or obese respondents, and interviewees that consider themselves to be in very good health are more likely to select options that entail an increase in physical exercise. Therefore, we should consider that people from these groups will favour more exercise in order to improve their health. To further investigate whether overweight and obese respondents are different in terms of utility functions from normal weight and underweight respondents, we analysed the data separately for the two subgroups following Swait & Louviere (1993), Louviere, Hensher & Swait, 2000, and Louviere et al. (2002, 2006), but found no differences across the two subgroups. Finally, those who declared themselves to be in very good health also have a positive interaction parameter with *Exercise*, which is coherent with the expectation that these people are in a better condition for undertaking physical activity.

The interaction terms with *Exercise* and the three other dummy variables related to the type of exercise (home based activities, commuting and vigorous leisure activities), are all negative. These coefficients suggest that respondents who are already doing some physical exercise are less willing to increase the amount of exercise. Alternatively, these coefficient estimates can be interpreted as suggesting that respondents who do not engage in vigorous physical exercise, do not walk or cycle at least two hours per week, or who do not engage in home-based activities such as gardening and taking care of children, are more likely to choose alternatives that offer an increase in their amount of physical exercise.

To explore heterogeneity of preferences for diet, we assessed the interaction of *Fat* with the *Overweight*, *Educated* and *Vigorous* dummy variables. Respondents who are overweight or obese do not appear to have significantly different preferences in terms of diet from respondents who are of normal weight or underweight, as the coefficient for the interaction term *Fat*Overweight* is not statistically significant. Respondents who had completed a university degree appeared to like a low fat diet as the coefficient for the interaction term between *Fat* an *Educated* is positive and statistically significantly different from zero. Finally, the last interaction term between *Fat* and *Vigorous* is negative and significant, indicating that respondents who undertake vigorous physical activity would not prefer a low fat diet. The last interaction term, between *Risk* and the dummy variable *Children* indicating whether respondents had dependent children, is negative, but not statistically significant, suggesting that having children does not make respondents more risk averse than respondents that do not have to look after children.

3.2 Willingness to pay

When we apply a RPL model to the data, we find a considerable improvement to the fit of the data compared to the previous two MNL models, as can be seen by the improvement in the log likelihood function of the model in Table 5.

Table 5 about here

This model has been estimated directly in WTP-space to avoid problems in computing posterior WTP estimates. We used normal distributions for *Exercise* and *Fat*, lognormal for *Cost,* while we did not allow for random heterogeneity for *Risk.* The output shows negative and highly significant coefficient estimates for the current choice and for risk, strengthening the results of the previous two models: respondents would prefer to change their lifestyle and would favour alternatives with lower risks of fatal CVD. Unobserved heterogeneity is captured by the spread (Sigma) of the normal distributions for *Exercise, Fat* and the lognormal distribution for *Cost*. All spread coefficients are statistically significant, suggesting that preferences vary across respondents. When we further look at the effects of socioeconomic variables, we confirm the findings from the MNL, however some of the previous interactions are now not statistically significant as the random parameters capture some heterogeneity that in MNL2 is considered observed.

The output from table 5 shows that some respondents have a positive and some have a negative WTP for *Exercise*, meaning that part of the sample are willing to pay to undertake physical activity and part are reluctant to do it, and therefore appear to require compensation. Similarly, we find that some respondents have a positive WTP and some have a negative WTP for *Fat*. Therefore, to investigate the WTP for *Exercise* and *Fat*, which are allowed to be heterogeneous across the sample, we use equation 2 to retrieve posterior individual WTP values. These values, reported in Table 6, can be used for policy analysis, as our sample mirrors the population well.

Table 6 about here

For *Exercise*, we find that the median WTP of the sample is almost zero, and the sample is split 51% with a positive WTP and 49% with a negative WTP. On average, respondents are, however, willing to pay 0.243 GBP per 100 MET. On the other hand, reducing the fat intake is considered negatively for the majority of the sample, as the median is equal to -0.312 and only 41% of the sample has a positive WTP for a reduction in fat intake. Even though the median WTP for fat reduction is negative, the mean WTP is positive, as driven by some respondents with very high WTP, and is equal to 1.387 GBP for a reduction of 100 grams of fat. Looking at the interactions, it is possible to conclude that respondents with a positive WTP are educated and normal weight or underweight, while obese and overweight respondents and respondents who do vigorous physical activity have a negative WTP.

4. Discussion and conclusion

Lifestyle choices, seen as long run decisions, imply certain risks for health. Individuals naturally trade off these risks, (presented here as fatal CVD risks), with money, physical exercise and changes in dietary habits. Our study is the first respondent's tailored DCE to assess the WTP for and the trade-offs *between* health risks and lifestyle behaviours. In our survey, we used respondent's specific choice experiments based on each individual's current health conditions, actual dietary and physical activity habits, and then presented respondents with realistic hypothetical lifestyle alternatives.

Our results show that many respondents recognize the value of reducing their fat intake and, in general, would also be willing to increase their level of physical exercise to reduce their health risks. We also find that males are more likely to engage in physical exercise, as confirmed by other research (see, for instance Biddle & Mutrie, 2008). More interesting is the positive preference of overweight individuals towards exercise but with significant heterogeneity in this regard. In fact, up to 51% of the sample has a positive WTP. Considering that 1 minute of moderate exercise such as stationary bicycling implies a consumption of 5.5 METs, respondents show a WTP of approximately 0.80 GBP per hour, which is about one third of the cost of accessing a gym in Northern Ireland, and is about one eighth of the minimum hourly wage, suggesting that one hour of moderate physical activity is only modestly valued by our respondents.

We find a mean WTP equal to 1.387 GBP for a reduction of 100 grams of fat. This equates to a WTP of 4.85 GBP per week for a 50 grams reduction of fat intake in a weekly diet, which corresponds to a reduction of about 60 grams of butter in a week. A reduction of 50 grams of fat per week equates to a reduction of about 7 grams of fat per day. For example, such a daily amount of fat is found in 20 grams of mature Cheddar cheese, or in one oatmeal biscuit, or in two slices of bacon. It is not surprising that some people are willing to pay to reduce their fat intake and, in fact, this is consistent with the attitude of the food industry that applies a price premium to low fat products.

We find an average WTP for reducing by 1 percentage point the risk of a fatal CVD event in the next 10 years equal to 0.632 GBP per week. This implies a value of 32.86 GBP per year, and, considering a 3.5% discount rate, over 10 years, this is equal to 282.85 GBP. As the current Northern Ireland population between 40 to 65 years old is comprised of 285,226 individuals, this would represent an aggregate WTP of £80.7 million. CVD costs the health care systems in the UK about £240 per person per year (Allender et al, 2008), which is equal to £3.7 billion over a ten year period (using a 3.5% discount rate and a reference population of 1,789,000 people) for the population of Northern Ireland. We find, therefore, that the aggregate WTP of £80.7 million is equivalent to 2% of the CVD cost in Northern Ireland. We conclude that a policy that would reduce the risk of a fatal CVD event by 1% is worth about 2% of the current Northern Ireland cost for CVD.

The results of this study provide useful guidance for addressing obesity and sedentary behaviour in Northern Ireland. Our models show that to improve their lifestyle, overweight and obese people would be more likely to do more physical activity than to change their diets. Therefore, public policies aimed to target obesity and its related illnesses in Northern Ireland should invest public money in promoting physical activity rather than healthier diets. However, as we also find that lifestyles characterised by increased levels of physical activity are more likely to be chosen by males, it is likely that to improve the lifestyles of females the government should subsidise healthy food choices. In terms of research, these findings suggest that we need to explore further the reasons behind people’s attachment to specific items of the Irish diet. With such knowledge, public policies might be better designed to discourage fat consumption.

Nonetheless, our study has some limitations that should be acknowledged. We have constrained our sample to subjects between 40 to 65 years of age, which may limit the broader generalization for other age groups in Northern Ireland. In addition, as the construction of the DCE questions is tailored to each individual, the need to ask detailed questions regarding diet and physical activity and presenting respondents with the risk tutorial prior to introducing the DCE questions brings with it a certain respondent burden.

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Figure 1: Example of question in the eating habits part of the questionnaire

amárach research

CHOICE 3 of 10 - Which option would you choose?

	Current Choice	Option A	Option B
Diet			
Boiled, mashed, instant or jacket potatoes	1-2 times week	1 per month	2-3 times a month
Beef: roast, steak, mince, stew or casserole	1-2 times week	1 per month	2-3 times a month
Savoury pies, eg. Meat pie, pork pie, pasties, steak & kidney pie, sausage rolls	2-3 times a month	1 per month	1 per month
Whole milk	Whole Milk	Skimmed Milk	Semi Skimmed Milk
Spread fat (different from butter) but not low-fat	2-3 times a month	1 per month	1 per month
Expenditure			
Increase in weekly expenditure in food(£)	No changes	£15 more	£5 more
Exercise			
Increase in moderate exercise(daily)	No changes	40 minutes	20 minutes
Cardio-vascular risk			
Your risk of a heart attack in the next 10 years(chances over 100%)	5.00 %	2.50 %	3.75 %
	Current Choice	Option A	Option B
I would choose			

Back OK Clear

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Figure 2: Example of a Discrete Choice Experiments question

Table 1: Attributes and levels

Attribute	Levels
Diet (reduction of the consumption of the respondent's five most unhealthy food items)	Current, light, medium, high and restricted diet
Cost (GBP per week)	0, 2, 5, 7, 10, 15, 18
Physical Exercise (increase in daily minutes)	0, 10, 20, 30, 40
Percentage risk reduction from respondent's actual risk	40, 50, 60, 75, 85

Table 2: Socioeconomic variables

Name variable	Description: Dummy variable	Mean
Unemployed	Equal to one if the respondent is unemployed, and zero otherwise	0.12
Male	Equal to one if the respondent is male, and zero if female	0.43
Home	Equal to one if the respondent practises home physical activity (such as gardening, household works or taking care of children) for, at least, two hours per week, and zero otherwise	0.80
Overweight	Equal to one if the respondent is either overweight or obese, and zero otherwise	0.57
Travellers	Equal to one if the respondent walks and/or cycles at least two hours per week, and zero otherwise	0.76
Vigorous	Equal to one if the respondent engages in regular vigorous physical activity, and zero otherwise	0.41
Very good health	Equal to one if the respondent declares he/she is in very good health, and zero otherwise	0.25
Educated	Equal to one if the respondent has a graduate degree, and zero otherwise	0.24
Children	Equal to one if the respondent has dependent children, and zero otherwise	0.61

Table 3: Socioeconomic statistics for the sample

SE statistics		
Income (annual income per household)		
Less than 3120		10.02%
3121-4160		9.83%
4161-5200		10.40%
5201-6240		7.90%
6241-7280		7.90%
7281-10400		9.06%
10401-15600		13.10%
15601-20000		13.49%
20000-40000		42.77%
More than 40000		0.00%
Mean		29,051
Age		
40-50		47.06%
50-55		21.91%
More than 55		31.03%
Mean		50.73
BMI		
Underweight BMI < 18.5		4.67%
Normal BMI 18.5-25		37.93%
Overweight BMI 25-30		31.03%
Obese BMI > 30		26.37%
Mean	26.85	
Sex		
Male	43%	
n	493	

Table 4: Results from MNL models

	MNL-1		MNL-2	
Name	**Value**	**|t-test|**	**Value**	**|t-test|**
Current choice	-0.323	6.29	-0.275	5.25
Cost	-0.101	15.93	-0.108	16.25
Exercise**	0.090	5.73	0.060	2.90
Fat**	-0.246	5.02	-0.390	4.37
Risk	-0.078	5.18	-0.075	4.62
Cost*Unemployed			-0.030	3.54
Exercise*Male			0.033	2.63
Exercise*Home			-0.007	11.10
Exercise*Overweight			0.060	3.76
Exercise*Travellers			-0.116	3.72
Exercise*Vigorous			-0.056	3.39
Exercise*Very good health			0.038	2.61
Fat*Overweight			0.142	1.42
Fat*Educated			0.242	2.78
Fat*Vigorous			-0.260	2.23
Risk*Children			-0.017	1.28
Log likelihood	-5260.640		-5160.909	
Observations	4930		4930	
Individuals	493		493	
ρ^2	0.028		0.044	
K	5		16	

** Parameters scaled multiplying by 100

Table 5: Results from RPL model in WTP-space

WTP-space				
Name	**Value**	**|t-test|**	**Interval conf. Lower band**	**Interval conf. Upper band**
Current choice	-2.331	25.50	-2.422	-2.240
-log(Cost) *	-1.643	18.50	-1.732	-1.554
Sigma	-1.544	14.82	-1.648	-1.439
Exercise**	-0.749	2.63	-1.034	-0.464
Sigma	3.093	18.98	2.930	3.255
Fat**	-0.419	0.33	-1.703	0.866
Sigma	11.845	11.37	10.803	12.886
Risk	-0.632	3.46	-0.814	-0.449
Cost*Unemployed	0.031	1.24	0.006	0.057
Exercise*Male	0.778	7.06	0.668	0.889
Exercise*Home	-0.080	0.26	-0.382	0.223
Exercise*Overweight	0.367	2.33	0.210	0.524
Exercise*Travellers	0.470	2.21	0.257	0.682
Exercise*Vigorous	-0.232	1.50	-0.386	-0.078
Exercise*Very good health	-0.189	1.25	-0.341	-0.038
Fat*Overweight	-0.269	0.18	-1.787	1.248
Fat*Educated	6.291	3.92	4.686	7.895
Fat*Vigorous	-2.462	1.78	-3.841	-1.082
Risk*Children	-0.028	0.17	-0.192	0.137
Log likelihood	-3717.060			
Observations	4930			
Individuals	493			
ρ^2	0.310			
K	19			

*the cost coefficient is equal to –exp(Estimated parameter)

** Parameters scaled multiplying by 100

Table 6 Median and Mean Conditional Willingness to pay

Attribute	Median	Mean (std. error)
WTP Exercise	0.019	0.243 (1.20)
WTP Fat	-0.312	1.387 (4.97)